A Comparison of Insect Diversity in Different Habitats and Regions of North Carolina

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Abstract

The goal of this study was to test the hypothesis that the Coastal Region of North Carolina has a greater phototaxic insect population than the Mountains of North Carolina. After placing multiple and single fluorescent light traps in the two regions, data were collected. Then the specimens were identified down to order and the results recorded on data sheets. After reviewing all the data, the Coastal Region was found to have a more diverse phototaxic insect population than the Mountains, but the Mountains had more insects captured overall.

Introduction

The old adage “Moths go towards the light” is not simply just a saying, but a scientific phenomenon which allows certain insects to be caught with traps. These traps, involving fluorescent lights shining to attract these insects relies on the tendencies of phototaxic organisms to go towards light. A phototaxic organism is one that bases movement off of light stimuli (Stork 1988). In these experiments, multiple differently colored light traps and single black light traps were set up in different places in the Coastal Region and Mountains in order to catch these phototaxic insects. The question being explored in this study is whether there is a difference in insect diversity between the Coastal Region and Mountains of North Carolina. For this particular study the Coastal Region is defined as all the area in North Carolina east of the Fall Line and the Mountains as all the area in North Carolina west of the Continental Divide. Because the specimens were collected using fluorescent light traps, our results are confined solely to phototaxic insects. One also must worry about confounding variables in the study such as experimental error or bias. This is why the data were complied with one multiple light trap and one blacklight trap per region to make sure all available phototaxic specimens are included. By

equally representing both trapping methods, variability is reduced and more reliable results are produced.

Methods

In one of the two different testing methods, six differently colored fluorescent lights were laid out in a circle in order to attract different insects. Each trap, set in a flat clear area in the woods, included a colored fluorescent light laid upon a vat of soapy water. After the insects were attracted to the light, many fell into the vat. This water would either immobilize or kill the insects, allowing them to be put into containers of alcohol by means of forceps, each different light having its own container. In the other method only a black light was used in the experiment. A line of black lights was strung across flat ground and turned on. Then a rope was tied around two trees and white sheets were hung over the rope, completely covering the line of black lights. Insects were, attracted to the light, and landed on the sheets where they were seized with forceps and put into a container of alcohol. After twenty minutes of collecting, the process stopped and the experiment was disassembled. Methods for the 2004 experiments are mostly similar in nature, except for the location of the testing grounds was different. The Coastal Region test was run in Southport in a park while the Mountain test was run on Snake Mountain near the city of Boone. After the specimens from both of the sites were collected they were taken back to the lab for identification. Using a key (Borror and White 1970), each specimen was identified down to the order. Statistical tests were run on the data. In order to test for diversity a Shannon Diversity test was run and the results were noted and interpreted. A Chi-Square goodness of fit test comparing all the orders was conducted to see if there was any significant difference between the amounts of organisms caught in both regions. After the data were collected, they were compiled together with data from 2004 (Summer Ventures in Science and Mathematics Field Biology

Class 2004) on a spread sheet. The spreadsheet consisted of three separate pages, one sheet containing compiled data from the Coastal Region, another with data from the mountains, and the last one containing the results of the statistical tests run on the data.

Results

The results of the study were interpreted from the spreadsheets produced from the experimental data. Tables 1 and 2 show the data collected from the Coastal Region and the Mountains, both having separate numbers for the individual experiments along with a total amount for both. These tables show how many individuals of each order are in the region along with totals which allow easy comparisons to be made between regions. Table 3 shows the results of a Shannon Diversity test which was run on statistical software and results computed and compiled onto a table (Brower & Zar 1998). The purpose of this test was to put statistical support behind what the tables show, making the data on the tables more significant. Table 4 shows the results of a Chi-Squared goodness of fit test which was run on the same software as the previous test for the same reason (Brower & Zar 1998).

Table 1: Coastal Region Compiled Data Table; number of insects captured.

Order	Multiple Lights	Black Light	Total
Hymenoptera	3	11	14
Coleoptera	10	12	22
Lepidoptra	15	21	36
Diptera	59	14	63
Ephemoptera	8	0	8
Hemiptera	2	2	4
Orthoptera	1	3	4
Neuroptera	0	1	1
Dermaptera	24	0	24
Plecoptera	0	2	2
Homoptera	7	0	7
Isoptera	0	4	4
Thysanoptera	20	1	21
Trichoptera	24	3	27
Odonata	0	0	0
Thysanura	1	0	1
Total	173	74	247

Table 2: Mountains Compiled Data Table; number of insects captured.

Family	Multiple Lights	Black Light	Total
Hymenoptera	33	6	39
Coleoptera	1	4	5
Lepidoptra	258	72	330
Diptera	80	30	110
Ephemoptera	58	7	65
Hemiptera	0	8	8
Orthoptera	1	1	2
Neuroptera	0	0	0
Dermaptera	0	1	1
Plecoptera	0	0	0
Homoptera	21	1	22
Isoptera	0	0	0
Thysanoptera	85	27	112
Trichoptera	17	6	23
Odonata	1	0	1
Thysanura	0	0	0
Total	555	163	718

Table 3: Shannon Diversity Test Results

	Mountains	Coastal Plain
Number of Orders	12	15
Shannon Diversity	0.715	0.967
Evenness	0.662	0.822
Richness	0.43	0.97

Table 4: Chi-Square Goodness of Fit Results

	X^2 Value	Significant (p=0.01)	More Insects per Order
Hymenoptera	10.87	Yes	Mountains
Coleoptera	9.48	Yes	Coastal Region
Lepidoptra	227.9	Yes	Mountains
Diptera	12.23	Yes	Mountains
Ephemoptera	42.96	Yes	Mountains
Hemiptera	0.75	No	
Orthoptera	0.17	No	
Neuroptera	0	No	
Dermaptera	20.35	Yes	Coastal Region
Plecoptera	0.5	No	
Homoptera	6.76	Yes	Mountains
Isoptera	2.25	No	
Thysanoptera	60.9	Yes	Mountains
Trichoptera	0.18	No	
Odonata	0	No	
Thysanura	0	No	

From the Shannon Diversity test it was clear that the Coastal Plain region was much more diverse than the Mountain region. Shannon Diversity is based on two factors. Richness or the number of species in relation to the sample size, and evenness, the relative number of

individuals per species in the sample. In order to graphically display the results, pie charts were constructed for each set of data. Figures 1 and 2 both show pie charts for both the Coastal Region and the Mountains. One can easily tell from these graphs that the Coastal Region is much more diverse in its phototaxic insect population than the Mountains

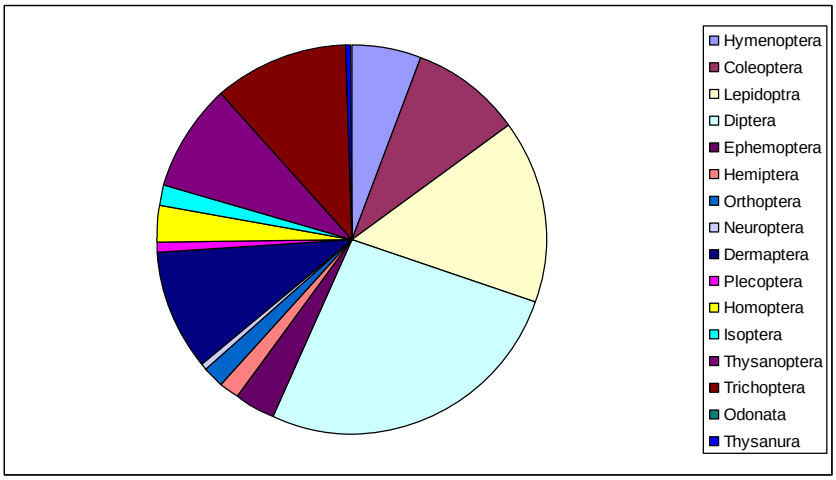

Figure 1. Pie chart for Coastal Region data; percent of insects per order

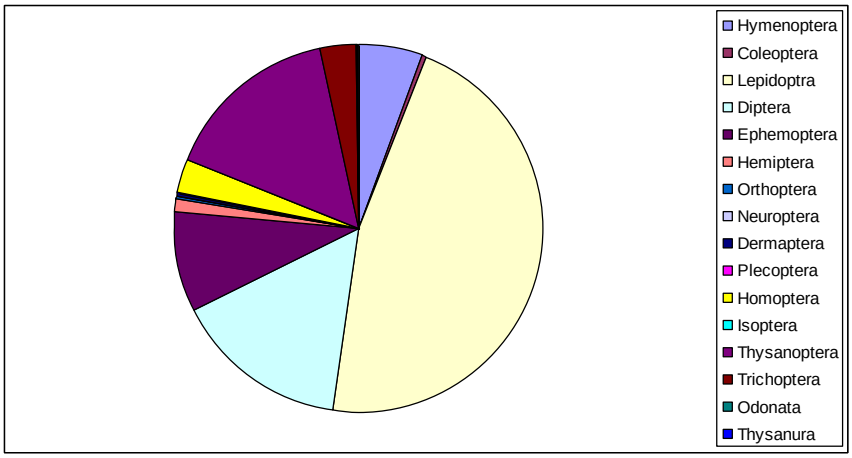

Figure 2. Pie Chart for Mountains Data; percent of insects per order

What cannot be seen on the pie charts is the actual number of individuals per order that were caught in the traps. For this data a bar graph was constructed for each region to visually show the

difference (Figures 3 and 4). One thing evident from these bar graphs is how many more insects were caught in the mountains and even how many more individuals in certain orders the Mountains had over the Coastal Region.

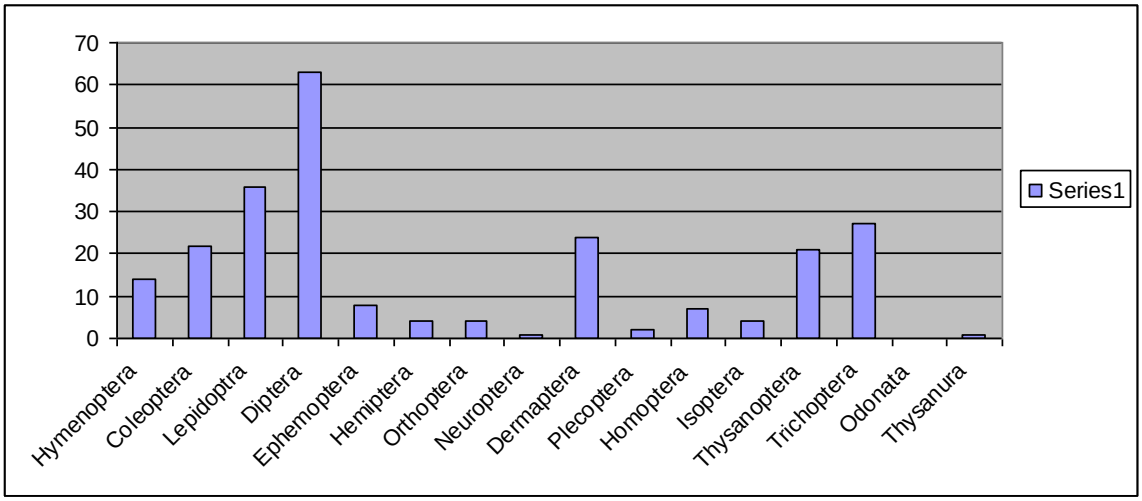

Figure 3: Bar Graph for the Coastal Region

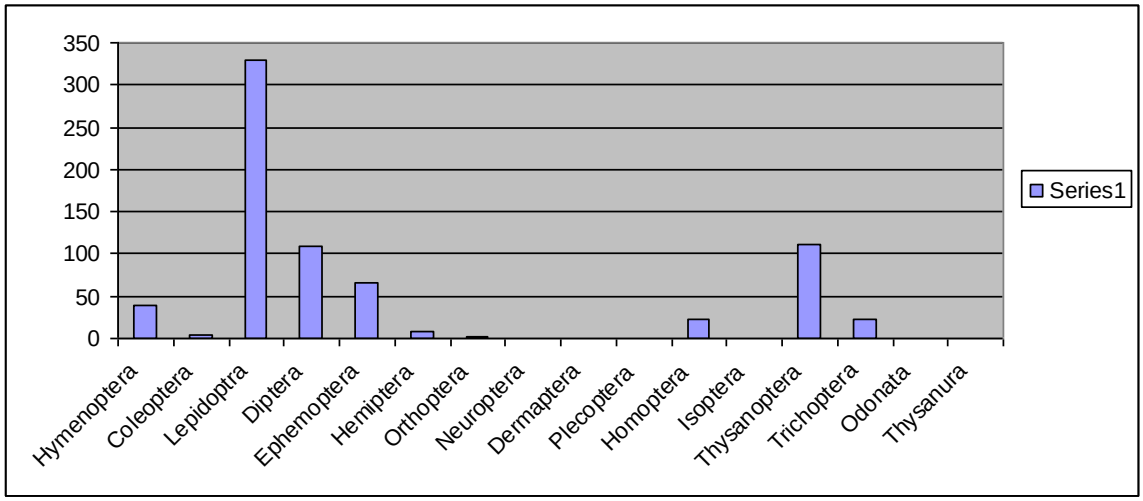

Figure 4: Bar Graph for the Mountains

In order to show statistically that the mountains contained more individuals in certain orders than the Coastal Region a Chi-square goodness of fit test was run. For this test, significant differences in the data heavily favored the generally indicated more insects per order in the

Mountains. From both these statistical tests we may make conclusions about the diversity of the two regions and can produce evidence to back up the hypothesis.

Discussion

By using statistical tests, the hypothesis given cannot be disproved by this data. The diversity index showed that the Coastal Region has more richness, diversity, and evenness than the Mountains, yet the data clearly showed that more individual insects were obtained in the Mountains. Furthermore the mountains had a higher amount of insects per order than the Coastal Region most of the time. This interpretation allows the existing hypothesis to be modified to: The Coastal Region of North Carolina has a higher phototaxic insect diversity than the Mountains, but the Mountains have a greater number of phototaxic individuals per order than the Coastal Region, when an order is represented in both regions. This can only be tested with another experiment, assuming that the same experimental protocols as the ones followed for the original experiments are followed. There may be many reasons for this, being the amount of water in each region. Perhaps it is because the Coastal Region has more diverse food for phototaxic insects, allowing for a more diverse population to thrive. Or perhaps the reason lies in the Mountains, such as limited food supply which would allow only adaptive phototaxic insects to survive. The Mountains also could have regionally unique predators which would decimate the populations of some phototaxic orders. But possibly the best explanation is that Coastal Region is more ecologically diverse than the mountains, including many more habitats which would facilitate greater insect diversity. In contrast to this, the mountains are less ecologically diverse and this allows the lower number of orders in the region to thrive and become more numerous than in the Coastal Region. The last explanation could be due to the climates of the regions, with the Coastal Region on average hotter than the mountains, and with more marshes,

bogs, swamps, and bays to add to the moisture in the air (Orr and Stuart 2000). This hot and humid climate seems to be a preferred insect environment as shown by insect studies done in the Amazon Rainforest, considered one of the world's most diverse insect populations (Stork 1988). In order to show that the Coastal Plain has greater diversity, an insecticide knock-down test would have to be run on randomly selected areas from both regions. This would not only allow us to test for phototaxic insects but also for non-phototaxic insects which would not be attracted to light. The data from a more complex study could reveal more about abiotic-biotic relations, and how much climate affects diversity and dominance. From this study one can speculate that relatively moderate climates allow a greater diversity of species because the species would not be pressured as much by evolution to produce radical habitat adaptations. Furthermore the more diverse plant life would provide more niches for species to reside in, allowing for more species to reside in a certain area. In contrast a more extreme climate, such as the mountains, would not be able to support greater species diversity because radical climates would force species residing there to make a large habitat adaptation, with those failing to do so being killed. Those species who do adapt end up dominating the areas in which they live and are able to grow in numbers significantly. If this is found to be true, it could lead to a greater understanding about evolution and biotic responses to climate change.

Conclusion

It is concluded that the original hypothesis can not be rejected based on the data observed in the study. By means of statistical tests, the data showed that the Coastal Region has a more diverse phototaxic insect population than the Mountains of North Carolina. Furthermore the Mountains had a greater amount of individuals caught in the traps and was statistically verified to have more individuals per order than the Coastal Region. In order to extrapolate the results to

a broader scale, more data would be required and more studies performed, yet the potential benefits of these extra tests could go further than just the realm of local entomology.

Literature Cited

Brower, Keith R. and Jerrold H. Zar. 1997. *Quantitative Analysis in Ecology*. Dubuque, Iowa. Brown Publishers.

Borror, Donald J. and Richard E. White. 1970. *A Field Guide to Insects America north of Mexico*. New York: Houghton Mifflin Company.

Orr, D.M, Jr. and A.W Stuart 2000. *The North Carolina Atlas*. UNC Press, Chapel Hill, NC.

Stork, Nigel E. 1988. Insect Diversity: facts, fiction and speculation. *Biological Journal of the Linnean Society 35*: 321-337.

Summer Ventures in Science and Mathematics Field Biology Class, 2004. UNC-Charlotte, Charlotte, NC.